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UK CL (Edition O) F1D DA1
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(54) Actuator for forming a flange on a wheelhouse

(57) An actuator for forming a flange on a wheelhousing 10 includes wall surfaces 160, 166 defining at least first and second separate, elongated, coaxial fluid chambers 136, 138. The first and second chambers have coaxial apertures extending therethrough. An elongated rod 174 extends through the coaxial apertures and has first and second pistons 146, 148 connected thereto for reciprocating respectively in the first and second chambers in response to fluid delivered and thereto. As shown, piston rods 144 and 174 respectively operate a clamping member 24 for the wheelhouse and a bending tool 16. Each piston rod is drawn by four pistons in tandem, each piston reciprocating in a chamber formed by a sleeve 160, 162 inserted in a housing bore. Adjacent sleeves are separated by wall members 168, 185.

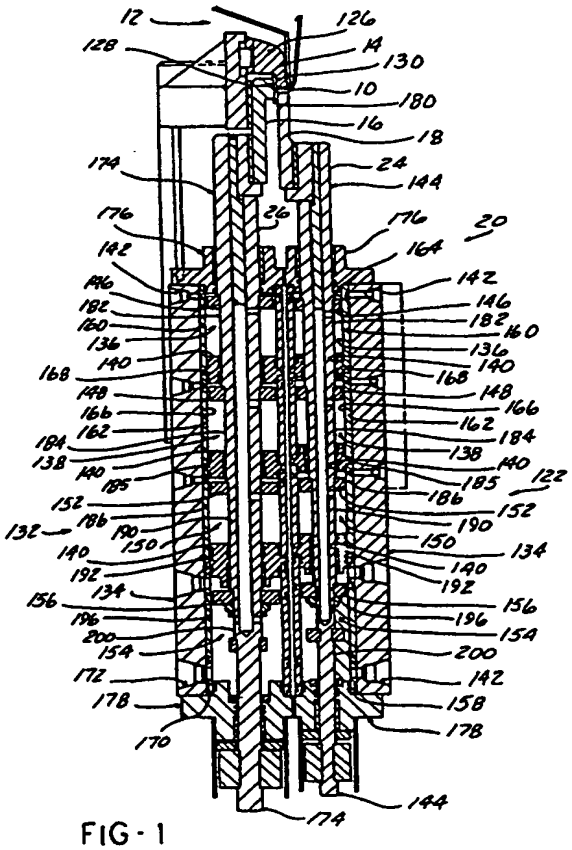

FIG - 1

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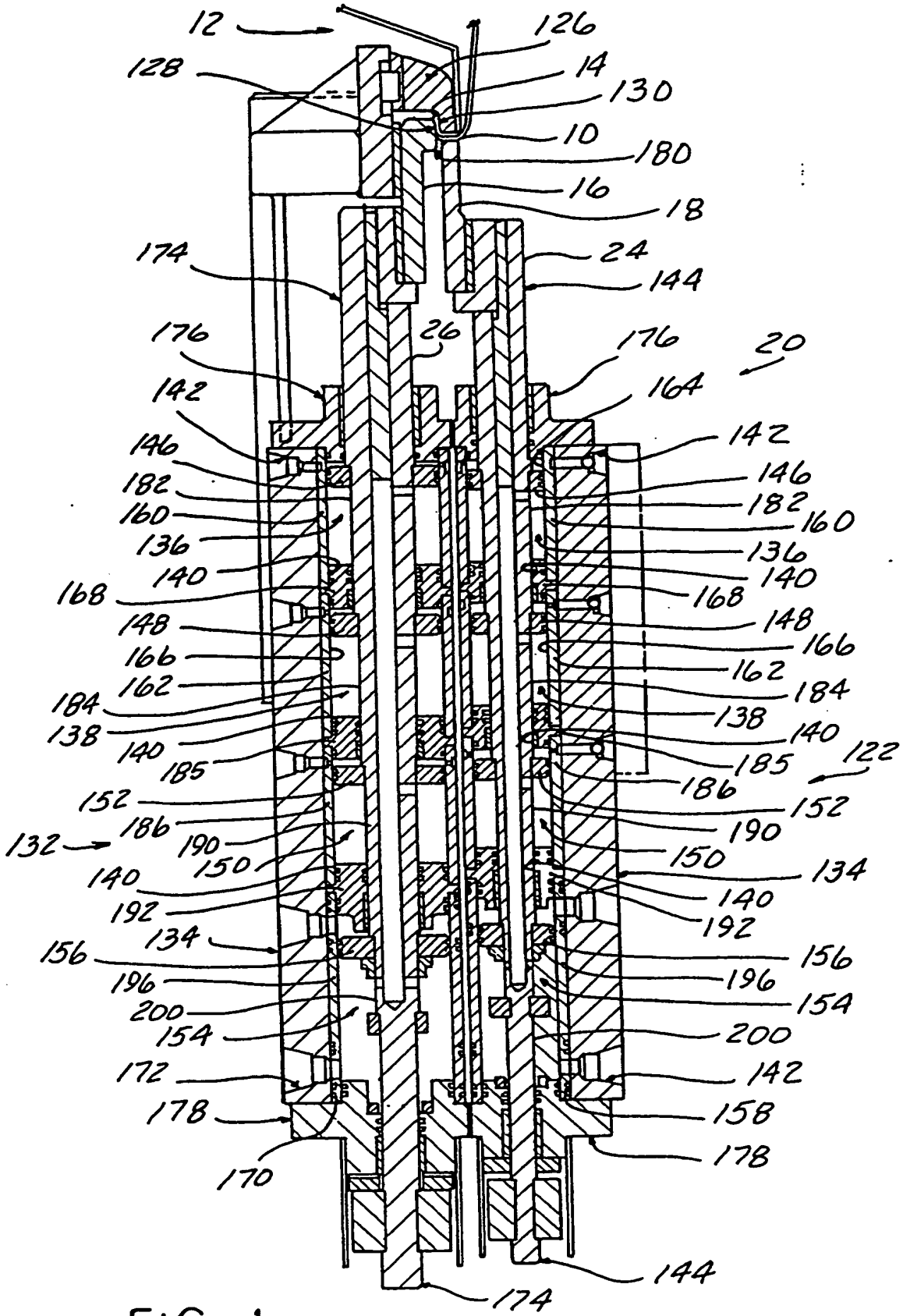
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FIG - 1

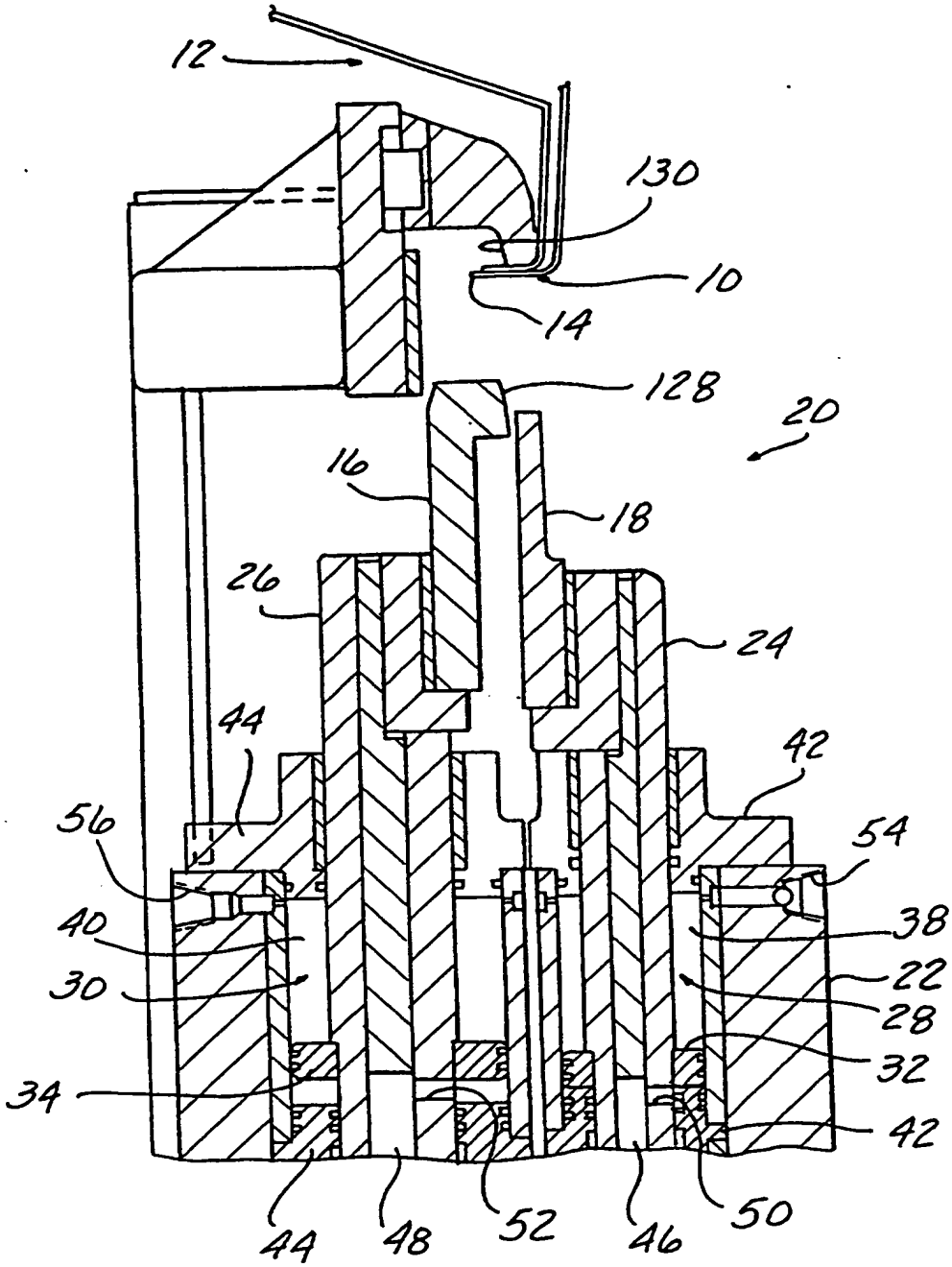
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FIG - 2

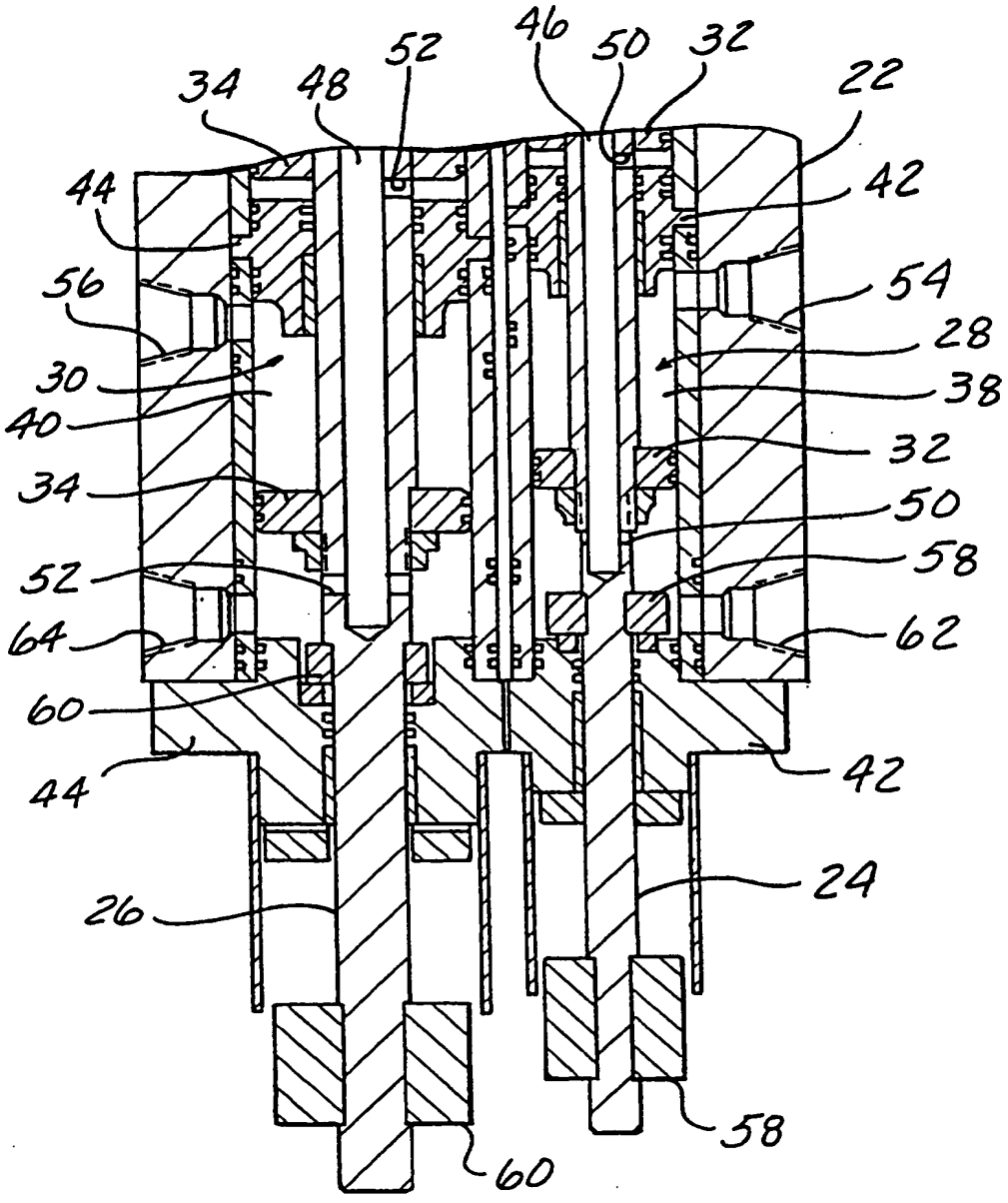
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FIG-3

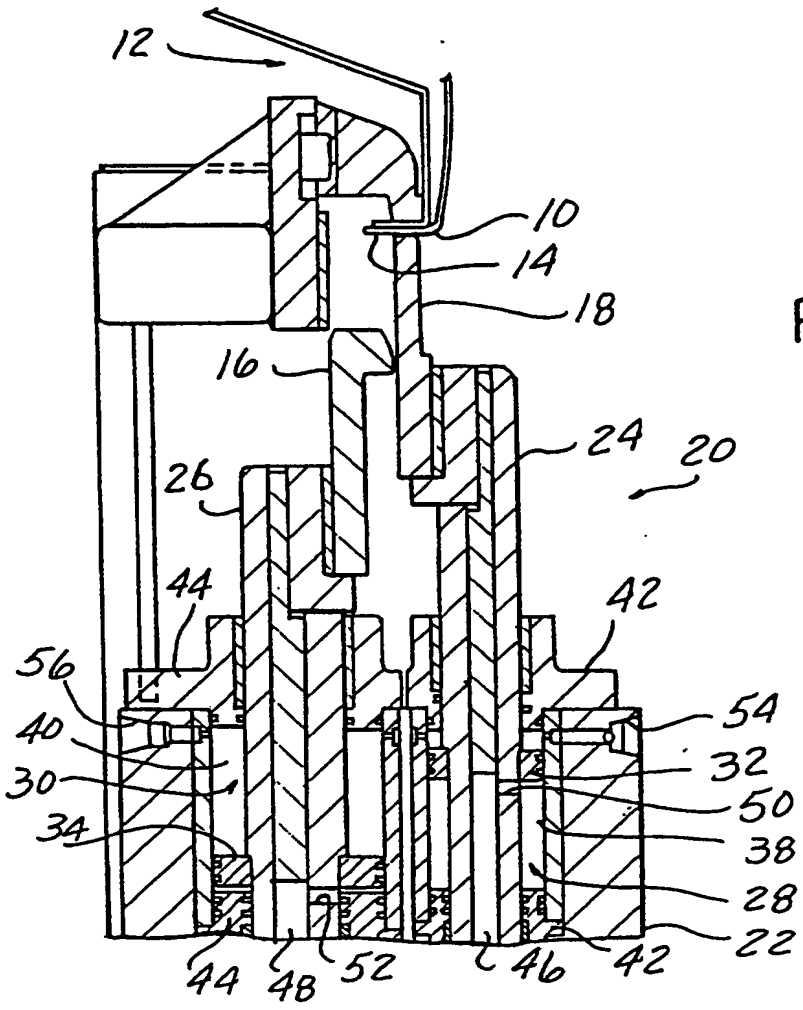
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FIG-4

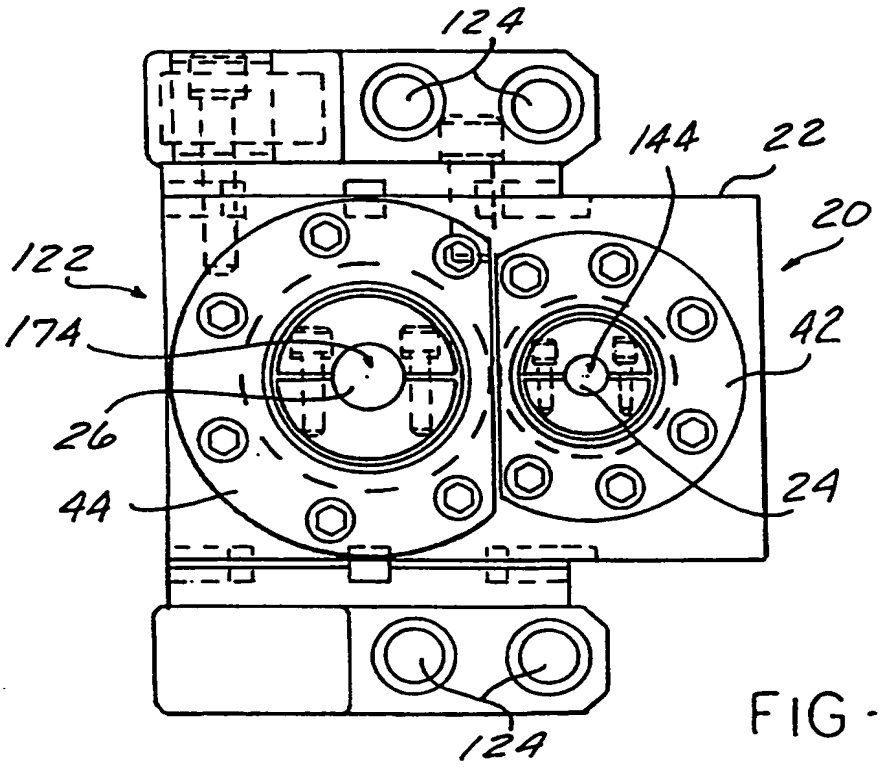
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FIG-5

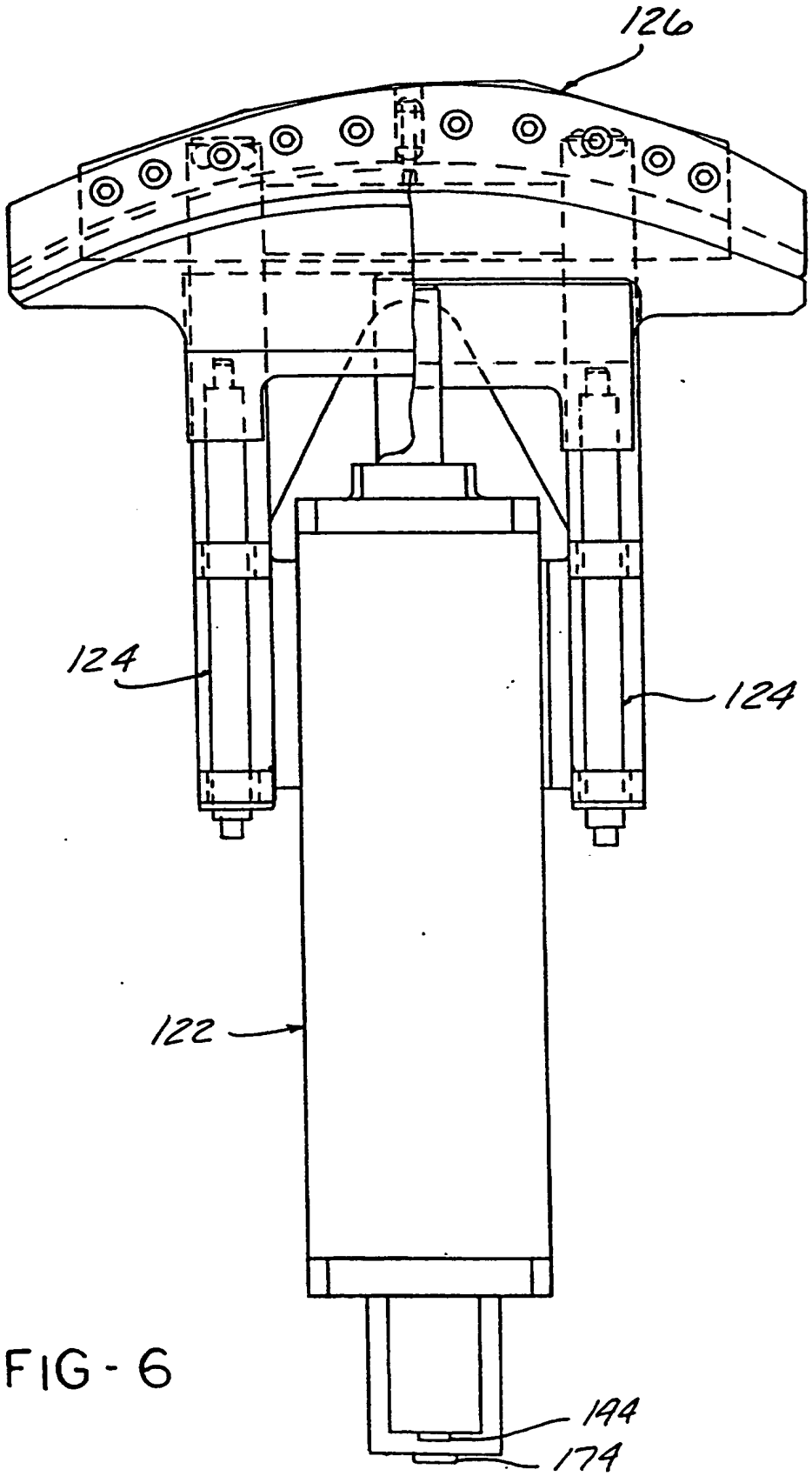

FIG-6

Title - ACTUATOR FOR FORMING A FLANGE ON A WHEELHOUSE

The present invention relates to an actuator for moving one tool with respect to another tool in a generally predetermined path, each tool having a surface or wall portion extending forwardly of the tool face and in substantial alignment with the direction of relative motion between the tools, where the surfaces or wall portions on co-acting tools are laterally offset to accommodate work therebetween, and are each arranged to overlap and engage a lateral surface on the co-acting tool during the approach of the tools for a deforming operation, and in particular, to an actuator having a plurality of coaxial pistons connected to a single rod member while being disposed in separate expandable fluid chambers.

It is generally known to perform a bending operation on a flange of a wheelhouse by clamping the flange from both sides of the clamp while wiping the free end of the flange with a wiping block, so as to bend the free end of the flange upward and away from the wheelhouse. The clamp and wiping block typically have an arcuate configuration in order to accommodate the arcuate shaped wheelhouse flange. Typically, the middle arcuate wheel portion of the wheelhousing is bent in this fashion, since this is the only portion of the wheelhousing where interference may occur, such as with chains placed on tires during adverse weather conditions or the like. In order to develop the force necessary to form the flange, a large actuator has been required. The size and weight of the actuator was greater than could be accommodated for automated robotic manipulation, and therefore has required manual manipulation in combination with a counter balance mechanism for use in current production line assembly operations.

It is desirable in the present invention to provide an actuator capable of generating sufficient force to form the flange in a wheelhouse, while maintaining a size and weight small enough to enable means for manipulating, such as robotic manipulation, or manual manipulation without the need for a counter balance mechanism. The present invention relates to an actuator, or a cylinder, for flanging a wheelhouse of a motor vehicle to prevent the flange of the wheelhouse from contacting and interfering with chains placed on the tires of the vehicle in response to adverse snow conditions. The present invention provides a light-weight design that still provides the necessary loads for performing the bending process of the flange. The apparatus provides a housing having a pair of shafts disposed within separate chambers of the housing for performing a pair of sequential steps. Each shaft has a plurality of pistons for providing the high loads required of the flange forming operation. The clamp is connected to one end of the first shaft and moves to and from a fixed block connected to the housing in order to secure the flange of the wheelhousing. The wiping block is connected to the second shaft of the apparatus, providing the wiping block with reciprocal movement to bend the free end of the flange upward and away from the motor vehicle tire.

The housing of the apparatus is essentially divided into two chambers for housing the first and second shafts. Both the first and second shafts have four independent chambers defined by cylindrical dividers. Within each of the chambers, a piston is attached to its corresponding shaft. Each of the shafts has a bore extending along the longitudinal axis of the shafts with a port leading from the bore of the shaft into each of the chambers defined by the dividers. Ports are also provided from the outside of the housing leading

into each of the chambers, such that the ports open into the chambers on one side of the pistons and the ports leading into the longitudinal bore of the shaft open into the chambers on the opposite side of the pistons. Thus, pressure is provided through one set of ports on one side of the pistons to move the shafts in one direction, while the remaining ports may supply air pressure to the opposite side of the pistons in order to move the shafts in the opposite direction. Adjustable, positive stops at the end of the shafts provide positive stops to limit the amount of travel for the clamp and wiping block.

In operation, the clamp is positioned over and clamped onto the flange of the wheelhouse of the motor vehicle. The clamp is actuated by supplying fluid pressure, such as compressed air, to a bottom port of the first chamber so that pressure is provided to one side of all four pistons on the first shaft, and the first shaft moves outward to positively clamp the flange in a clamped position. The wiping block is actuated by providing pressure to a bottom port of the second chamber, such that fluid pressure is provided to one side of the four pistons attached to the second shaft. The second shaft moves outward, and the wiping block bends the flange of the wheelhouse. After the wiping block completes its stroke, fluid pressure is withdrawn from one side of the pistons and supplied to the opposite side of the pistons in order to provide the return sweep of the wiping block. Once the wiping block is returned, the clamp is unclamped by withdrawing fluid pressure from one side of the pistons and providing fluid pressure to the opposite side of the pistons. Thus, the shaft retracts, the clamp opens, and the apparatus is moved away from the motor vehicle.

Therefore, in its simplest form, the present invention provides an actuator including wall means for defining at least first and second separate, elongated, coaxial fluid chambers. The first and second fluid

chambers have coaxial apertures extending therethrough. Fluid passage means selectively communicates with at least the first and second fluid chambers for delivering pressurized fluid, and for removing fluid from the fluid chambers. Elongated rod means extend through the coaxial apertures and have at least first and second pistons connected thereto for reciprocating respectively in the first and second fluid chambers in response to fluid delivered and removed by the fluid passage means.

Other objects, advantages and applications of the present invention will become apparent to those skilled in the art when the following description of the best mode contemplated for practicing the invention is read in conjunction with the accompanying drawings.

The invention will now be described further by way of example only with reference to the accompanying drawings in which:

Figure 1 is a cross-sectional view of an apparatus for forming a flange on a wheelhousing according to the present invention with a clamp and a wiping block both in a closed position;

Figure 2 is a cross-sectional detailed view showing the clamp and the wiping block both in an open position;

Figure 3 is a cross-sectional detailed view of a fluid chamber or piston chamber according to the present invention with rods connected to the clamp and the wiping block both in an open position with corresponding stops on each rod limiting reciprocal movement of the rod;

Figure 4 is a cross-sectional detailed view showing the clamp in a closed position while the wiper block is still in an open position;

Figure 5 is an end view of the apparatus according to the present invention; and

Figure 6 is a plan view of the apparatus.

The present invention discloses an apparatus and method for bending a flange 10 of a wheelhouse 12 by clamping the flange 10 from both sides with a clamp 18, while wiping the free end 14 of the flange 10 with a wiping block 16, so as to bend the free end 14 of the flange 10 upward away from the wheelhouse 12. The clamp 18 and wiping block 16 both have an arcuate configuration in order to accommodate the arcuate shaped wheelhouse 12. Only the middle arcuate portion of the wheelhouse 12 is bent in order to provide clearance for the tire of the vehicle, particularly when enlarged due to the inclusion of additional optional equipment, such as snow chains.

The apparatus 20 of the present invention assembles a first element or portion thereof along an edge of a second element and into overlapping relationship with the second element. The assembly is accomplished in whole or in part by deforming the first element. The deformation is accomplished by stressing the first element beyond the elastic limit. The apparatus 20 according to the present invention includes means, such as wiping block 16, to juxtapose, associate or fasten together a plurality of work parts by stressing one part beyond the elastic limit thereof. The apparatus 20 according to the present invention also includes, means, such as clamp 18, for engaging a first work part and including means, such as wiping block 16, for engaging a second work part which means are adapted to bring the two parts into juxtaposed relationship, or cause one of the work parts to intimately engage the other to thereby fasten the work parts together. The apparatus 20 according to the present invention is employed to perform a bending operation on a sheet or thin plate of material in the plane of the width for forming the flange, the added wall means on the dies

serve to inhibit crumpling or buckling of the thin material.

The apparatus 20 for forming the flange 10 provides a light-weight design capable of delivering the necessary loads for performing the bending process. The apparatus 20 includes a housing 22 having a pair of shafts 24, 26 disposed within separate chambers 28, 30 respectively, of the housing 22 for performing a pair of sequential steps. Each shaft 24, 26 has a plurality of pistons 32, 34 respectively for providing the high loads required during the flange forming operation. The clamp 18 is connected to one end of the first shaft 24 and moves reciprocally toward and away from a fixed block 36 connected to the housing 22 in order to secure the flange 10 of the wheelhousing 12. The wiping block 16 is connected to the second shaft 26 of the apparatus 20 to provide the wiping block 16 with reciprocal movement to bend the free end 14 of the flange 10 away from the future location of a vehicle tire.

The housing 22 of the apparatus 10 is essentially divided into the two chambers 28, 30 for housing the first and second shafts 24, 26. Both the first and second shafts 24, 26 have four independent chambers 38, 40 respectively, defined by cylindrical dividers 42, 44 respectively. Within each of the chambers 38, 40, a piston 32, 34 is attached to the corresponding shaft 24, 26. Each of the shafts 24, 26 has a bore 46, 48 respectively, extending along the longitudinal axis of the shafts 24, 26 with a port 50, 52 leading from the bore 46, 48 of the shaft 24, 26 into each of the chambers 38, 40 defined by the dividers 42, 44. Ports 54, 56 are also provided from the outside of the housing 22 leading into each of the chambers 38, 40 respectively, such that the ports 54, 56 open into the chambers 38, 40 on one side of the pistons 32, 34 and the ports 50, 52 leading into the longitudinal bores 46, 48 of the shafts 24, 26 open into the chambers 38, 40 on the

opposite side of the pistons 32, 34. Fluid pressure can therefore be provided through one set of ports on one side of the pistons 32, 34 to move the shafts 24, 26 in one direction, while the remaining ports may supply fluid pressure to the opposite sides of the pistons 32, 34 in order to move the shafts 24, 26 in the opposite direction. Adjustable positive stops 58, 60 at the end of the shafts 24, 26 respectively, provide positive stops to limit the amount of travel for the clamp 18 and wiping block 16.

In operation, the clamp 18 is unclamped and positioned over the flange 10 of the wheelhouse 12 of a motor vehicle. The clamp 18 is actuated by supplying fluid pressure to a bottom port 62 of the first chamber 28, so that pressure is provided to one side of all four pistons 32 on the first shaft 24, such that the first shaft 24 moves outward to positively clamp the flange 10 in a clamped position. The wiping block 16 is then actuated by providing fluid pressure to a bottom port 64 of the second chamber 30, such that fluid pressure provided to one side of the four pistons 32 attach to the second shaft 26, such that the second shaft 26 moves outward, and the wiping block 16 bends the flange 10 of the wheelhouse 12. After the wiping block 16 completes its stroke, fluid pressure is withdrawn from one side of the pistons 34 and supplied to the opposite side of the pistons 34 in order to provide the return sweep of the wiping block 16. Once the wiping block 16 has returned, the clamp 18 is unclamped by withdrawing fluid pressure from the one side of the pistons 32 and providing fluid pressure to the opposite side of the pistons 32. Thus, the shaft 24 retracts, the clamp 18 opens, and the apparatus is moved away from the motor vehicle.

The apparatus 20 of the present invention reduces the weight of existing flange forming devices by as much as 50%, while still providing the necessary press loads to bend the wheelhouse flange during the forming

operation. The apparatus 20 according to the present invention uses a single housing 22 having a pair of parallel shafts 24, 26 with a plurality of tandem pistons 32, 34 in order to perform the two step sequential operation.

The apparatus 20 may include actuator means 122 for moving, or means 124 for guiding, one tool, such as wiping block 16 with respect to another tool, such as support means 126 in a generally predetermined path. Each tool may include a surface 128, or wall portion, extending forwardly of the tool face and in substantial alignment with the direction of relative motion between the tools, which surfaces or wall portions on co-acting tools are laterally offset to accommodate work therebetween, and are each arranged to overlap and engage a lateral surface 130 on the co-acting tool 126 during the approach of the tools for a deforming operation.

The present invention discloses actuator means 122 for forming a flange 10 on a wheelhouse 12. The actuator means 122 may include a cylinder or actuator 132 having wall means 134 for defining at least first and second separate, elongated, coaxial fluid chambers or piston chambers 136, 138. The first and second fluid or piston chambers 136, 138 have coaxial apertures 140 extending therethrough. Fluid passage means 142 selectively communicate with at least the first and second chambers 136, 138 for delivering pressurized fluid and for removing fluid from the chambers 136, 138. Elongated rod means 144 extends through the coaxial apertures 140 and has at least first and second pistons 146, 148 connected thereto for reciprocating respectively in the first and second chambers 136, 138 in response to fluid delivered and removed by the fluid passage means 142.

The wall means 134 may also include at least a third separate, elongated, coaxial fluid or piston chamber 150. The third fluid or piston chamber 150 has

an aperture 140 extending coaxial with the other coaxial apertures 140 of the first and second chambers 136, 138. The fluid passage means 142 may also selectively communicate with the third chamber 150 for delivering pressurized fluid and for removing fluid from the chamber 150. The elongated rod means 144 also may extend through the coaxial aperture 140 and include at least a third piston 152 connected thereto for reciprocating respectively in the third chamber 150 in response to fluid delivered and removed by the fluid passage means 142.

The wall means 134 may also include at least a fourth separate, elongated, coaxial fluid or piston chamber 154 with an aperture 140 extending coaxial with the coaxial apertures 140 of the first, second and third chambers 136, 138 and 150. The fluid passage means 142 may also selectively communicate with the fourth chamber 154 for delivering pressurized fluid and for removing fluid from the fourth chamber 154. The elongated rod means 144 may also extend through the coaxial apertures 140 and include at least a fourth piston 156 connected thereto for reciprocating respectively in the fourth chamber 154 in response to fluid delivered and removed by the fluid passage means 142.

The fluid passage means 142 may extend at least in part through the elongated rod means 144 for communicating between at least corresponding sides of the first and second pistons 146, 148 within the first and second chambers 136, 138 respectively. The elongated rod means 144 may also include stepped progressive reductions in diameter spaced longitudinally along a length thereof corresponding to at least the first and second chambers 136, 138. The first and second pistons 146, 148 may have equal outer peripheries and be connected to the rod means 144 through first and second apertures of different diameters corresponding to the stepped progressive reductions in diameter of the elongated rod means 144.

The wall means 134 may include the housing 22 having at least one elongated aperture 158 extending therethrough. First and second elongated sleeve or liner means 160, 162 slidably engage within the aperture 158 and have inner surfaces 164, 166 respectively defining the first and second fluid or piston chambers 136, 138. An intermediate wall means 168 slidably engages within the aperture 158 and is interposed between the first and second means 160, 162 for forming a stationary divider wall between the first and second chambers 136, 138. The fluid passage means 142 may be formed at least in part between the housing 22 and the first and second means 160, 162, such as sleeve means or liner means, for communicating with the first and second fluid or piston chambers 136, 138.

The housing 22 may include a second elongated aperture 170 extending therethrough. First and second elongated liner or sleeve means 136, 138 can be slidably engaged within the second aperture 170. The first and second means 136, 138 have inner surfaces 164, 166 as previously described with respect to the first aperture in the housing 22. Intermediate wall means 168 can be slidably engaged within the second aperture 170 and interposed between the first and second liner means 136, 138 for forming a stationary divider wall between the first and second fluid or piston chambers 136, 138. The first and second piston chambers 136, 138 have coaxial apertures 140 extending therethrough. Second fluid passage means 172 is provided for selectively communicating with the first and second piston chambers 136, 138 of the second aperture 170 for delivering pressurized fluid for removing fluid from the chambers 136, 138. Second elongated rod means 174 extends through the coaxial apertures 140 of the first and second piston chambers 136, 138 and has at least first and second pistons 146, 148 connected thereto for reciprocating respectively in the first and second chambers 136, 138 in

response to fluid delivered and removed by the second fluid passage means 172. The wall means 134 can include first and second end cap means 176, 178 connected to opposite ends of the aperture extending through the housing 22 for closing the aperture while allowing at least one end of the elongated rod means 144 to extend outwardly through one of the end cap means 176, 178.

The apparatus 20 according to the present invention may also include at least one wheelhouse flange die means 180 connected to one end of the second elongated rod means 174 for forming a flange on a wheelhousing of a vehicle side panel. An opposing support means 126 is connected to the housing 122 for supporting the housing 22 and die means 180 during the flange forming operation. The support means 126 is positionable in opposing relationship to the clamp 18 for interposing the wheelhousing therebetween while the die means 180, such as wiping block 16 moves with respect to the clamped flange of the vehicle side panel to bend the flange between the surfaces 128 of the die means 180 and support means 126. Guide means 182 is provided for guiding movement of the die means 180 and support means 126 while forming the flange on the wheelhousing of the vehicle side panel.

The actuator means 122 according to the present invention can be assembled by a method comprising the steps of providing the housing means 22 with an aperture extending therethrough, connecting first end cap means 176 to close one end of the aperture in the housing means 22. The first end cap means 176 has a rod receiving aperture 140 extending therethrough. Rod means 144 is inserted through the rod receiving aperture 140 of the first end cap means 176 for reciprocating between first and second end limits of movement. The rod means 144 may have longitudinally spaced, progressively reduced diameter portions extending from a first end to a second end. First liner means or sleeve means 160 is inserted

in the aperture of the housing means 22 for abutting against the first end cap means 176. A first piston 146 can be connected on the rod means 144 for engaging between the rod means 144, and the first sleeve means 160. The first piston 146 is connected to a first reduced diameter portion 182 of the rod means 144 for reciprocating with the rod means 144 between the first and second end limits of movement. An intermediate, radially extending, wall means 168 is slidably inserted on the rod means 144 to enclose the first piston 146 within a first chamber 136 defined by the first end cap means 176, the first sleeve means 160 and the intermediate wall means 168. Second liner means or sleeve means 162 is inserted in the aperture of the housing means 22 for interposing the intermediate wall means 168 between the first and second sleeve means 160, 162. A second piston 148 can be connected on the rod means 144 for engaging between the rod means 144 and the second sleeve means 162. The second piston 148 is connected to a second reduced diameter portion 184 of the rod means 144. Second end cap means 178 is connected to the housing means 22 for closing an opposite end of the aperture in the housing means 22.

The actuator 132 according to the present invention can also be assembled including the steps of inserting a second intermediate radially extending wall means 168 slidably on the rod means 144 to enclose the second piston 148 within the second fluid chamber 138 defined by the second intermediate wall means 168, the second sleeve means 162 and the first intermediate wall means 168. Third sleeve means or liner means 186 can be inserted in the aperture of the housing means 22 for interposing the second intermediate wall means 168 between the second and third sleeve means or liner means 148, 186. A third piston 152 can be connected on the rod means 144 for engaging between the rod means 144 and the third sleeve means 186. The third piston 152 can be

connected to a third reduced diameter portion 190 of the rod means 144.

The assembling method can also include the steps of inserting a third intermediate radially extending wall means 192 slidably on the rod means 144 to enclose the third piston 152 within a third fluid chamber 150 defined by the third intermediate wall means 192, the third sleeve means 186 and the second intermediate wall means 185. Fourth sleeve or liner means 196 can be inserted in the aperture of the housing means 22 for interposing the third intermediate wall means 192 between the third and fourth sleeve or liner means 186, 196. A fourth piston 156 can be connected on the rod means 144 for engaging between the rod means 144 and the fourth sleeve or liner means 196. The fourth piston 156 can be connected to a fourth reduced diameter portion 200 of the rod means 144.

The assembling method for the actuator 132 can also include the housing means 22 having a second elongated aperture 170 extending therethrough and connecting the first cap means 176, or a third cap means, to close one end of the second aperture 170 in the housing means 22. The assembling process for the second rod means 174 is the same as previously described for the first drive means 144 including inserting the first liner means 160, connecting a first piston head 146, inserting an intermediate radially extending plate means 168, inserting second liner means 162, connecting a second piston head 148 and connecting second cap means 178. In the preferred configuration, one of the rod means is connected to clamp 18, while the other is connected to the wiping block 16. The rod means 144, 174 are operable independently of one another to form the flange 10 in a wheelhouse 12 as previously described.

While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiment, it is to be

understood that the invention is not to be limited to the disclosed embodiments but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims, which scope is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures as is permitted under the law.

AIMS

1. An actuator for forming a flange on a wheelhousing comprising:

wall means for defining at least first and second separate, elongated, coaxial fluid chambers, said first and second fluid chambers having coaxial apertures extending therethrough;

fluid passage means for selectively communicating with at least said first and second fluid chambers for delivering pressurized fluid and for removing fluid from said fluid chambers; and

elongated rod means, extending through said coaxial apertures and having at least first and second pistons connected thereto, for reciprocating respectively in said first and second fluid chambers in response to fluid delivered and removed by said fluid passage means.

2. The actuator of claim 1 further comprising:

said wall means further defining at least a third separate, elongated, coaxial fluid chamber, said third fluid chamber having an aperture extending coaxial with said coaxial apertures of said first and second fluid chambers;

said fluid passage means for selectively communicating with at least said third fluid chamber for delivering pressurized fluid and for removing fluid from said fluid chamber; and

said elongated rod means, extending through said coaxial aperture and having at least a third piston connected thereto, for reciprocating respectively in said third fluid chamber in response to fluid delivered and removed by said fluid passage means.

3. The actuator of claim 2 further comprising:

said wall means further defining at least a fourth separate, elongated, coaxial fluid chamber, said

fourth fluid chamber having an aperture extending coaxial with said coaxial apertures of said first, second and third fluid chambers;

said fluid passage means for selectively communicating with at least said fourth fluid chamber for delivering pressurized fluid and for removing fluid from said fluid chamber; and

said elongated rod means, extending through said coaxial apertures and having at least a fourth piston connected thereto, for reciprocating respectively in said fourth fluid chamber in response to fluid delivered and removed by said fluid passage means.

4. The actuator of claim 1 further comprising:

said fluid passage means extending at least in part through said rod means for communicating between at least corresponding sides of said first and second pistons within said first and second fluid chambers respectively.

5. The actuator of claim 1 further comprising:

said elongated rod means having stepped progressive reductions in diameter spaced longitudinally along a length thereof corresponding to said first and second fluid chambers.

6. The actuator of claim 5 further comprising:

said first and second pistons having equal outer peripheries and connected to said rod means through first and second apertures.

7. The actuator of claim 1 further comprising:

said wall means including a housing having an elongated aperture extending therethrough, first and second elongated sleeve means, slidably engaged within said aperture and having an inner surface, for defining said first and second fluid chambers, and intermediate

wall means, slidably engaged within said aperture and interposed between said first and second sleeve means, for forming a stationary divider wall between said first and second fluid chambers.

8. The actuator of claim 7 further comprising:

said fluid passage means at least in part formed between said housing and said first and second sleeve means for communicating with said first and second fluid chambers.

9. The actuator of claim 7 further comprising:

said housing having a second elongated aperture extending therethrough, first and second elongated liner means, slidably engaged within said second aperture and having an inner surface, for defining first and second piston chambers, and intermediate wall means, slidably engaged within said second aperture and interposed between said first and second liner means, for forming a stationary divider wall between said first and second piston chambers, said first and second piston chambers having coaxial apertures extending therethrough;

second fluid passage means for selectively communicating with said first and second piston chambers for delivering pressurized fluid and for removing fluid from said piston chambers; and

second elongated rod means, extending through said coaxial apertures of said first and second piston chambers and having at least first and second pistons connected thereto, for reciprocating respectively in said first and second piston chambers in response to fluid delivered and removed by said second fluid passage means.

10. The actuator of claim 7 further comprising:

said wall means including first and second end cap means connected to opposite ends of said aperture

extending through said housing for closing said aperture while allowing at least one end of said rod means to extend outwardly through one of said end cap means.

11. The actuator of claim 10 further comprising:

at least one wheelhouse flange die means connected to said one end of said rod means extending outwardly from one of said end caps for forming a wheelhousing flange on a vehicle side panel.

12. The actuator of claim 11 further comprising:

an opposing support means connected to said housing for supporting said housing and die means during a flange forming operation, said support means positionable in opposing relationship to said die means for interposing said wheelhousing therebetween.

13. The actuator of claim 11 further comprising:

guide means for guiding movement of said die means while forming said wheelhousing flange.

14. An actuator for forming a flange on a wheelhousing comprising:

wall means for defining at least first and second separate, elongated, coaxial fluid chambers, said first and second fluid chambers having coaxial apertures extending therethrough, said wall means including a housing having an elongated aperture extending therethrough, first and second elongated sleeve means, slidably engaged within said aperture and having an inner surface, for defining said first and second fluid chambers, and intermediate wall means, slidably engaged within said aperture and interposed between said first

and second sleeve means, for forming a stationary divider wall between said first and second fluid chambers;

fluid passage means for selectively communicating with at least said first and second fluid chambers for delivering pressurized fluid and for removing fluid from said fluid chambers; and

elongated rod means, extending through said coaxial apertures and having at least first and second pistons connected thereto, for reciprocating respectively in said first and second fluid chambers in response to fluid delivered and removed by said fluid passage means, said elongated rod means having progressive stepped reductions in diameter spaced longitudinally along a length thereof corresponding to said first and second fluid chambers.

15. The actuator of claim 14 further comprising:

said fluid passage means extending at least in part through said rod means for communicating between at least corresponding sides of said first and second pistons within said first and second fluid chambers respectively.

16. An actuator for forming a flange on a wheelhousing comprising:

an elongated housing having a constant diameter bore therethrough;

a first end cap at one end of said housing having a first rod-receiving bore therethrough;

a rod having a first diameter engageable through said first rod-receiving bore, said rod having first and second shoulders spaced longitudinally from one another to define at least first and second reduced diameter portions of said rod diameter, wherein said first rod diameter is greater than said first reduced

diameter, and said first reduced diameter is greater than said second reduced diameter;

a first piston engageable with said first reduced diameter portion of said rod adjacent said first shoulder and having an outer diameter less than said constant diameter bore;

a first cylindrical sleeve having an outer diameter engageable with said constant diameter bore of said housing and an inner diameter engageable with said outer diameter of said first piston;

an intermediate, radially extending, piston chamber wall having a first periphery engageable with said constant diameter bore of said housing and a second periphery engageable with said inner diameter of said first cylindrical sleeve, said wall having an aperture therethrough engageable with said first reduced diameter portion of said rod to enclose said first piston within a first piston chamber;

a second piston engageable with said second reduced diameter portion of said rod adjacent said second shoulder and having an outer diameter less than said constant diameter of said bore;

a second cylindrical sleeve having an outer diameter engageable with said constant diameter bore of said housing and an inner diameter engageable with said outer diameter of said second piston; and

a second end cap at an opposite end of said housing having a second rod-receiving bore therethrough.

17. A method of assembling an actuator for forming a flange on a wheel housing comprising the steps of:

providing housing means having an aperture extending therethrough;

connecting first end cap means to close one end of said aperture in said housing means, said first end cap means having a rod-receiving aperture extending therethrough;

inserting rod means through said rod-receiving aperture of said first end cap means for reciprocating between first and second end limits of movement, said rod means having longitudinally spaced, progressively reduced diameter portions extending from a first end to a second end;

inserting first sleeve means in said aperture of said housing means for abutting against said first end cap means;

connecting a first piston on said rod means for engaging between said rod means and said first sleeve means, said first piston connected to a first reduced diameter portion of said rod means for reciprocating with said rod means between said first and second end limits of movement;

inserting an intermediate radially extending wall means slidably on said rod means to enclose said first piston within a first fluid chamber defined by said first end cap means, said first sleeve means and said intermediate wall means;

inserting second sleeve means in said aperture of said housing means for interposing said intermediate wall means between said first and second sleeve means;

connecting a second piston on said rod means for engaging between said rod means and said second sleeve means, said second piston connected to a second reduced diameter portion of said rod means; and

connecting second end cap means to said housing means for closing an opposite end of said aperture in said housing means.

18. The method of claim 17 further comprising the steps of:

inserting a second intermediate radially extending wall means slidably on said rod means to enclose said second piston within a second fluid chamber

defined by said second intermediate wall means, said second sleeve means and said intermediate wall means;

inserting third sleeve means in said aperture of said housing means for interposing said second intermediate wall means between said second and third sleeve means; and

connecting a third piston on said rod means for engaging between said rod means and said third sleeve means, said third piston connected to a third reduced diameter portion of said rod means.

19. The method of claim 18 further comprising the steps of:

inserting a third intermediate radially extending wall means slidably on said rod means to enclose said third piston within a third fluid chamber defined by said third intermediate wall means, said third sleeve means and said second intermediate wall means;

inserting fourth sleeve means in said aperture of said housing means for interposing said third intermediate wall means between said third and fourth sleeve means;

connecting a fourth piston on said rod means for engaging between said rod means and said fourth sleeve means, said fourth piston connected to a fourth reduced diameter portion of said rod means.

20. The method of any one of claims 17 to 19 further comprising the steps of:

providing housing means having a second aperture extending therethrough;

connecting first cap means to close one end of said second aperture in said housing means, said first cap means having a rod-receiving aperture extending therethrough;

inserting second rod means through said rod-receiving aperture of said first cap means for

reciprocating between first and second end limits of movement, said second rod means having longitudinally spaced, progressively reduced diameter portions extending from a first end to a second end;

inserting first liner means in said second aperture of said housing means for abutting against said first cap means;

connecting a first piston head on said second rod means for engaging between said second rod means and said first liner means, said first piston head connected to a first reduced diameter portion of said second rod means for reciprocating with said second rod means between said first and second end limits of movement;

inserting an intermediate radially extending plate means slidably on said second rod means to enclose said first piston head within a first piston chamber defined by said first cap means, said first liner means and said intermediate plate means;

inserting second liner means in said second aperture of said housing means for interposing said intermediate plate means between said first and second liner means;

connecting a second piston head on said second rod means for engaging between said second rod means and said second liner means, said second piston head connected to a second reduced diameter portion of said second rod means; and

connecting second cap means to said housing means for closing an opposite end of said second aperture in said housing means.

21. An actuator assembled by the method according to any one of claims 17 to 20.

22. An actuator substantially as herein described with reference to Figures 1 to 6 of the accompanying drawings.

23. A method of assembling an actuator substantially as herein described with reference to the accompanying drawings.

The Patent Office

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Claims searched: 1 to 23

Examiner: Trevor Berry
Date of search: 1 November 1996

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Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): F1D (DA1)

Int Cl (Ed.6): F15B

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 2238010 A	HWA CHIN MACHINERY	1, 5
X	GB 2156001 A	FESTO KG	1-3
X	GB 2009321 A	CATERPILLAR TRACTOR	1
X	GB 1571046	WESTIN and BACKLUND	1-3
X	EP 0561074 A1	HAW-RAN KAO	1-6
X	US 5375994	OTTO MANNER	1-6
X	US 4506867	McDERMOTT INC	1

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.